CLAIMS

1. A coated cutting tool comprising a substrate and a coating on the substrate, the coating comprising an inner layer, an intermediate layer, and an outer layer, each comprising at least one layer;

the inner layer:

(a) being composed of at least one material selected from the group consisting of the carbide, nitride, carbonitride, boride, boronitride, borocarbonitride, oxide, oxycarbide, oxynitride, and oxycarbonitride of the elements belonging to the IVa, Va, and VIa groups in the periodic table; and

(b) including at least one layer having a columnar-crystal structure;

the outer layer being composed of at least one oxide selected from the group consisting of aluminum oxide, zirconium oxide, hafnium oxide, and their solid solutions;

the intermediate layer:

(c) being composed of titanium boronitride, TiB_xN_y (x, y: atomic %), that satisfies

$$0.001 < x/(x+y) < 0.04 \quad \text{... formula 1;}$$

(d) having an average thickness of 0.1 to 1 μm; and

(e) having a surface roughness of 50 to 500 nm expressed by the vertical distance between the peak line and the valley line within a reference length of 1 μm.

2. A coated cutting tool comprising a substrate and a coating on the substrate, the coating comprising an inner layer, an intermediate layer, and an outer

layer, each comprising at least one layer;

the inner layer:

(a) being composed of at least one material selected from the group consisting of the carbide, nitride, carbonitride, boride, boronitride, borocarbonitride, oxide, oxycarbide, oxynitride, and oxycarbonitride of the elements belonging to the IVa, Va, and VIa groups in the periodic table; and

(b) including at least one layer having a columnar-crystal structure;

the outer layer being composed of at least one oxide selected from the group consisting of aluminum oxide, zirconium oxide, hafnium oxide, and their solid solutions;

the intermediate layer:

(c) containing:

(c1) titanium boronitride, TiB_xN_y (x, y: atomic %), that satisfies

$$0.001 < x/(x+y) < 0.04 \quad \text{... formula 1; and}$$

(c2) at least one element contained in at least one of the inner layer and the outer layer, except Ti, B, and N;

(d) having an element distribution in that:

(d1) when contained in the intermediate layer, the at least one element contained in the inner layer decreases its amount continuously or stepwise from the inner-layer side toward the thicknesswise center of the intermediate layer; and

(d2) when contained in the intermediate layer, the at least one element contained in the outer layer decreases its amount continuously or step-

wise from the outer-layer side toward the thicknesswise center of the intermediate layer;

(e) having an average thickness of 0.1 to 1 μm; and

(f) having a surface roughness of 50 to 500 nm expressed by the vertical distance between the peak line and the valley line within a reference length of 1 μm.

3. A coated cutting tool as defined by claim 1 or 2, wherein the titanium boronitride, TiB_xN_y (x, y: atomic %), in the intermediate layer satisfies

$$0.003 < x/(x+y) < 0.02 \quad \text{... formula 2.}$$

4. A coated cutting tool as defined by claim 1 or 2, wherein the intermediate layer is composed of titanium oxyboronitride, $TiB_xN_yO_z$ (x, y, z: atomic %), that satisfies

$$0.001 < x/(x+y) < 0.04 \quad \text{... formula 1}$$

and

$$0.0005 < x/(x+y+z) < 0.04 \text{ and } 0 < z/(x+y+z) < 0.5 \quad \text{... formula 3.}$$

5. A coated cutting tool as defined by claim 1 or 2, wherein the intermediate layer:

(a) comprises:

(a1) titanium boronitride, TiB_xN_y (x, y: atomic %), at the inner-layer side, the titanium boronitride satisfying

$$0.001 < x/(x+y) < 0.04 \quad \text{... formula 1; and}$$

(a2) titanium oxyboronitride, $TiB_xN_yO_z$ (x, y, z: atomic %), at the outer-layer side, the titanium oxyboronitride satisfying

$0.001 < x/(x+y) < 0.04$ ... formula 1 and

$0.0005 < x/(x+y+z) < 0.04$ and $0 < z/(x+y+z) < 0.5$ ... formula 3; and

(b) has a structure in which the amount of the oxygen content increases from the inner-layer side toward the outer-layer side.

6. A coated cutting tool as defined by any one of claims 1 to 5, wherein the inner layer has an average thickness of 1.0 to 20.0 μm and the outer layer has an average thickness of 0.5 to 10.0 μm.

7. A coated cutting tool as defined by any one of claims 1 to 6, wherein the or each layer of the at least one layer having a columnar-crystal structure and being included in the inner layer:

(a) is composed of one of titanium carbonitride and titanium oxycarbonitride;

(b) has an average thickness of 1.0 to 20.0 μm; and

(c) has an aspect ratio of at least 5 in the columnar-crystal structure.

8. A coated cutting tool as defined by any one of claims 1 to 7, wherein the outer layer is composed mainly of α-type Al_2O_3.

9. A coated cutting tool as defined by any one of claims 1 to 8, wherein the coating further comprises at the outside of the outer layer an identification layer that:

(a) is composed of at least one material selected from the group consisting of the carbide, nitride, carbonitride, oxide, oxycarbide, oxynitride, and oxycarbonitride of the elements belonging to the IVa, Va, and VIa groups in the

periodic table; and

(b) has an average thickness of 0.2 to 5.0 μm.

10. A coated cutting tool as defined by any one of claims 1 to 9, wherein the outermost layer of the coating has an average surface roughness, *Rmax*, of 0.2 to 1.3 μm within a reference length of 5 μm at the portion for making contact with a workpiece except the vicinity of the cutting edge when measured by a method that observes the cross section of the tool.

11. A coated cutting tool as defined by any one of claims 1 to 10, wherein the outermost layer of the coating has a surface roughness, *Rmax*, of at most 0.2 μm within a reference length of 5 μm in the vicinity of the cutting edge when measured by a method that observes the cross section of the tool.

12. A coated cutting tool as defined by any one of claims 1 to 11, wherein the substrate is made of cemented carbide composed of:

(a) a hard phase that:

(a1) consists mainly of tungsten carbide; and

(a2) contains at least one material selected from the group consisting of the carbide, nitride, carbonitride, and their solid solutions of the metals belonging to the IVa, Va, and VIa groups in the periodic table, excluding tungsten carbide; and

(b) a binder phase that contains at least one element selected from the iron-group metals.